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(71) Applicant : **LINTEC Corporation**
Honcho 23-23 Itabashi-ku
Tokyo 173 (JP)

(72) Inventor : **Takahashi, Kazuhiro**
3-17 Shiba 5-chome
Kawaguchi-shi, Saitama 333 (JP)
Inventor : **Nakada, Yasukazu**
14-28 Shibashita 1-chome
Kawaguchi-shi, Saitama 333 (JP)
Inventor : **Maruoka, Shigenobu**
2-68 Furuichiba, Saiwai-ku
Kawasaki-shi 211 (JP)
Inventor : **Tsuchida, Ichiro**
205 Funato
Koshigaya-shi, Saitama 343 (JP)
Inventor : **Saito, Takanori**
2-2-604, Satsukidaira 2-chome
Misato-shi, Saitama 341 (JP)

(74) Representative : **Holmes, Michael John et al**
Frank B. Dehn & Co. European Patent
Attorneys Imperial House 15-19 Kingsway
London, WC2B 6UZ, (GB)

(54) **Photochromic compositions.**

(57) Photochromic compositions comprising an organic photochromic compound and a tertiary amine dissolved or dispersed in an organic high molecular weight binder, which may be formed into photochromic films or coated onto a surface of a substrate to form photochromic laminates.

EP 0 467 552 A1

The present invention relates to photochromic compositions, more particularly to photochromic materials with good light resistance which may be repeatedly and reversibly coloured and decoloured over a long period of time.

Photochromism means that characteristic of a material whereby it develops a colour under irradiation with exciting radiation such as ultraviolet rays but returns to the initial uncoloured state after the ultraviolet irradiation when allowed to stand or when the material is irradiated with infrared or visible rays or is heated. Thus photochromism means that a material may be repeatedly and reversibly coloured and decoloured.

Photochromic compounds exhibit the above-mentioned characteristics; the colour density of the compounds in the coloured and decoloured states varies with the intensity of the exciting radiation and the duration of irradiation. Such compounds have been widely used in conjunction with materials such as window glasses in buildings and lenses in sunglasses, thereby utilizing their photochromic characteristics. Furthermore, photochromic materials using such photochromic compounds have possible applications as image-forming materials for copying, recording and the like.

Photochromic compounds may be broadly classified as either organic or inorganic.

Most inorganic photochromic compounds are solid, granular materials typically having a higher specific gravity than that of organic high molecular weight compounds such as are commonly used as binders for photochromic compositions. Accordingly it is often difficult to dissolve or homogeneously disperse inorganic photochromic compounds in such organic high molecular weight compounds. On the other hand, organic photochromic compounds can normally be homogeneously mixed with organic high molecular weight compounds, and so can be used to produce photochromic films exhibiting uniform colouration and decolouration, and to produce photochromic laminates exhibiting such uniform colouration and decolouration in which a photochromic layer is laminated on a substrate.

However, some problems still occur with organic photochromic compounds. For example, if an organic photochromic compound is irradiated with exciting radiation for a long period of time, the compound may be oxidized and therefore suffer deterioration and at least partial loss of its photochromic characteristics.

Therefore, various methods have been proposed to improve photochromic compositions containing organic photochromic compounds. Specifically it has been proposed to lessen the deterioration of an organic photochromic compound by adding hydroxybenzophenone, hydroxybenzotriazole or derivatives thereof to the composition (as described in U.S. Patent No. 3,212,898), by adding a hindered amine compound thereto (as described in U.S. Patent No. 3,488,290) and by adding a nickel complex thereto (as described in Japanese Patent laid-open Publication No. 58(1983)-173181). Also known are a method of adding a thioether compound to the composition, as described in Japanese Patent Laid-open Publication No. 58(1983)-113203, and a method of adding a hindered phenol compound or a phosphite compound thereto, as described in U.S. Patent No. 3,488,290.

However, ultraviolet absorbing agents such as hydroxybenzophenone and hydroxybenzotriazole absorb ultraviolet rays required for exciting the organic photochromic compound to develop a colour, and thus by their presence lower the light sensitivity of the photochromic composition. Alternatively, deterioration of the organic photochromic compound caused by application of light may be accelerated, depending on the nature of the organic photochromic compound and the ultraviolet absorbing agent used.

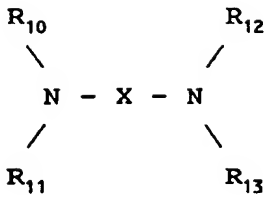
Hindered amine light stabilizers (HALS) typically contain at least one secondary amino group and may exhibit a plurality of functions, for example as a singlet oxygen quencher, a radical-trapping agent and a hydroperoxide decomposing agent. However, photochromic compositions containing a hindered amine light stabilizer and an organic photochromic compound in practice exhibit insufficient light resistance; hence there is a need for photochromic compositions with improved light resistance, particularly in cases where the resulting photochromic material is expected to be used repeatedly.

The photochromic compositions containing nickel complexes and organic photochromic compounds also exhibit insufficient light resistance, and additionally are coloured owing to the nickel complex even in the absence of exciting irradiation.

Further, in the cases where hindered phenol compounds, phosphite compounds or thioether compounds are used, the resulting photochromic compositions also exhibit insufficient light resistance.

The present invention provides novel photochromic compositions comprising an organic photochromic compound dissolved or dispersed in an organic high molecular weight binder, characterised in that a tertiary amine is also dissolved or dispersed in the binder; such compositions are capable of exhibiting substantially uninhibited light sensitivity and good light resistance.

One class of tertiary amines useful in photochromic compositions of the invention comprises compounds having the formula (I):



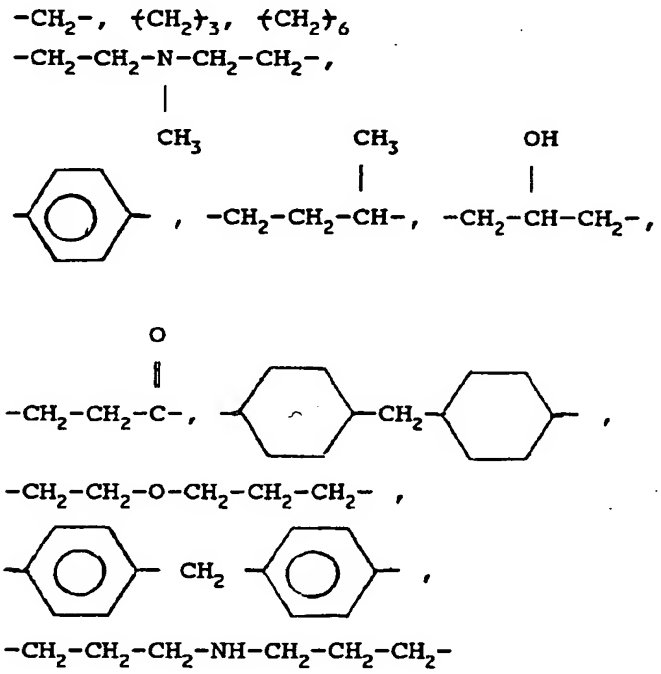
(I)

wherein each of R_{10} to R_{13}, which may be the same or different, represents an alkyl or epoxyalkyl group having up to 4 carbon atoms and optionally substituted by at least one N-, S- or O-containing substituent, and X is an alkylene group optionally including in the carbon chain thereof at least one of N, S or O and/or optionally carrying at least one N-, S- or O-containing substituent, or is an optionally substituted cycloalkylene, arylene (e.g. phenylene) or N-, S-, O- or P-containing heterocyclic ring or a plurality of such rings optionally interlinked by one or more alkylene groups.

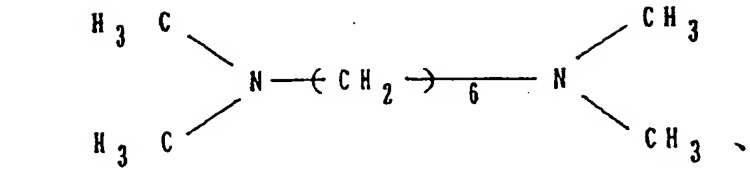
Examples of groups which may be present as R_{10} to R_{13} in formula (I) include methyl, ethyl, the propyl and butyl groups, 2-hydroxyethyl and 2,3-epoxypropyl.

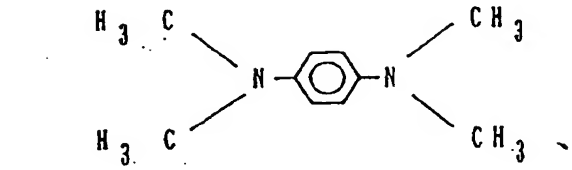
Substituents which may be present on X groups in formula (I) include alkyl groups (e.g. methyl or ethyl), alkoxy groups (e.g. methoxy or ethoxy), and halogen atoms (e.g. Cl or Br).

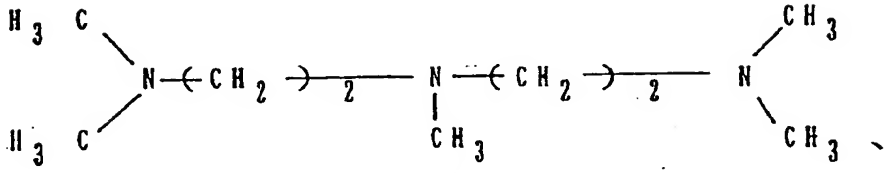
Examples of linking groups X are as follows:-

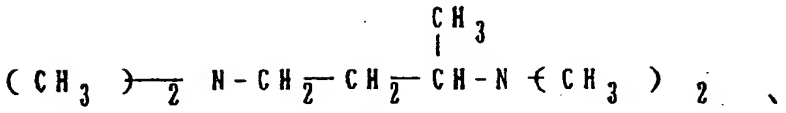


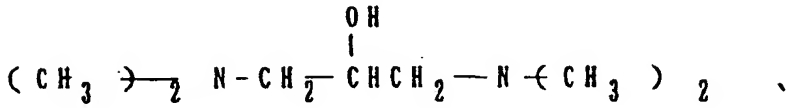
Examples of specific tertiary amines of formula (I) include:-

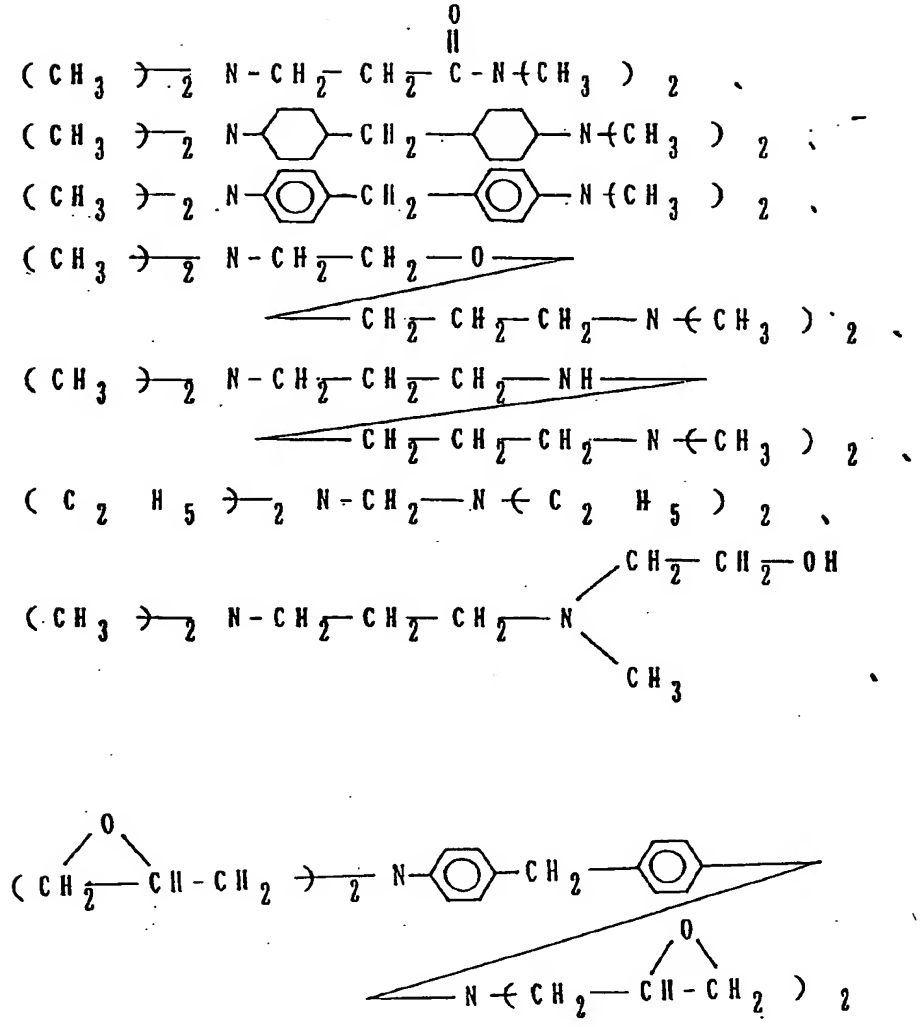




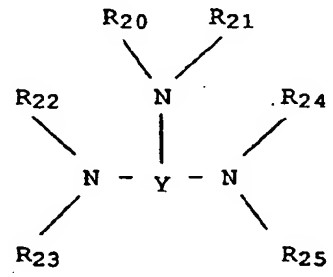








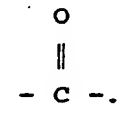
A second class of tertiary amines useful in photochromic compositions according to the invention comprises compounds having the formula (II):



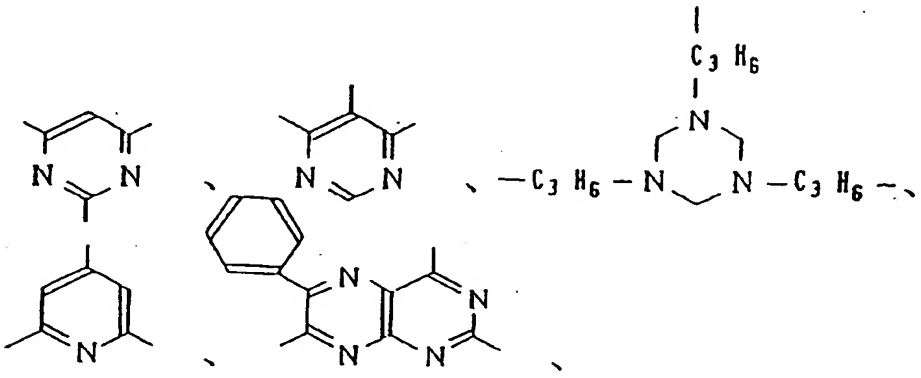
(II)

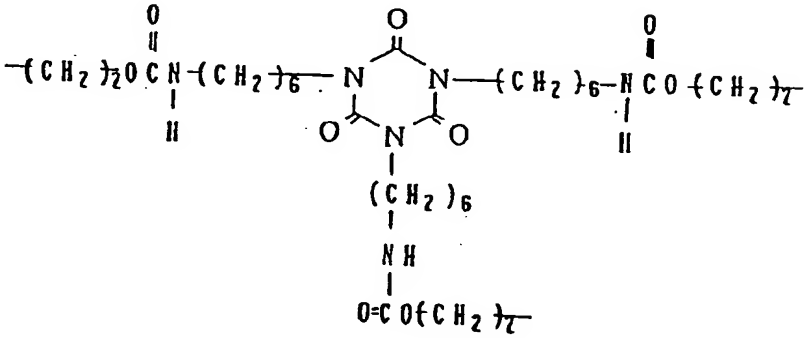
wherein each of R_{20} to R_{25}, which may be the same or different, represents an alkyl group containing up to 4 carbon atoms and optionally substituted by at least one N-, S- or O-containing substituent, and Y is an optionally substituted cycloalkane or N-, S-, O- or P- containing heterocyclic ring, said cycloalkane or heterocyclic ring

being bonded to each tertiary nitrogen atom either directly or by way of an alkylene group optionally containing at least one of N, O or

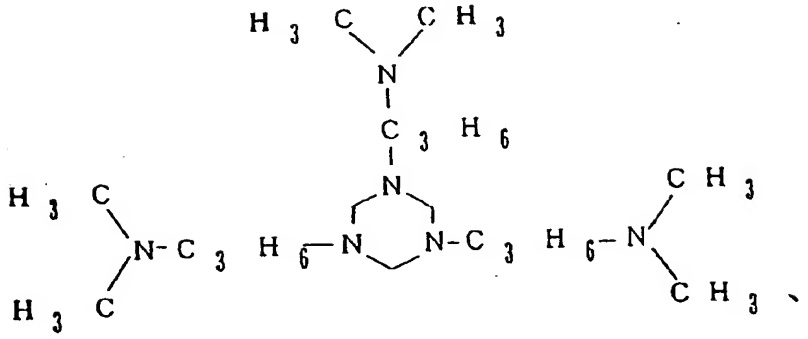


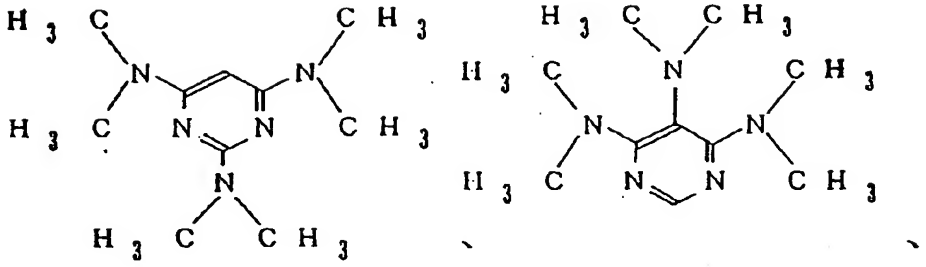
Examples of linking groups y are as follows:

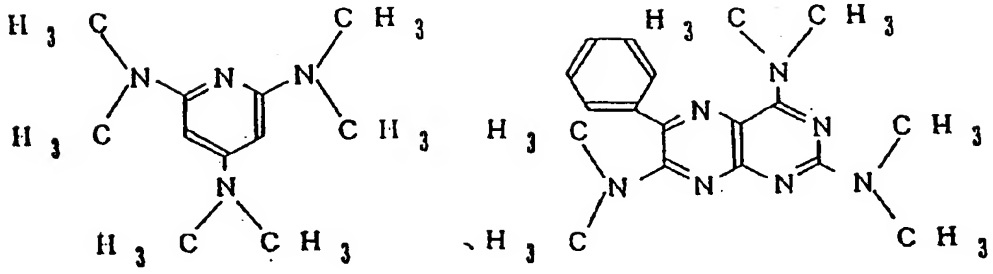


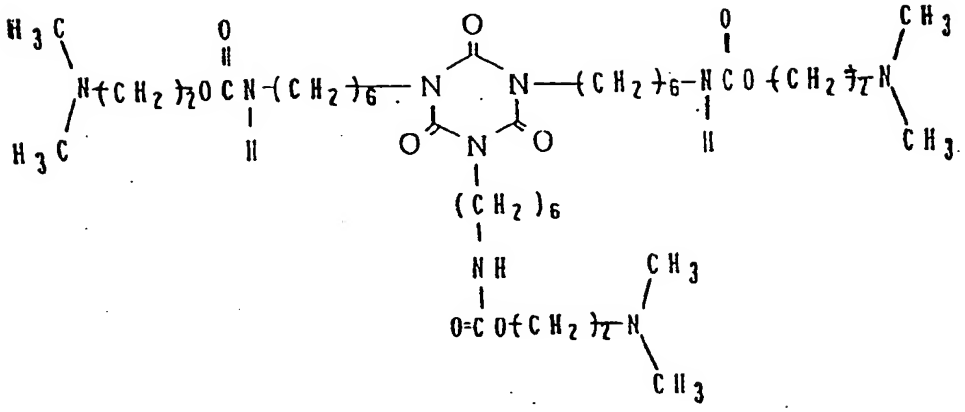


Examples of specific tertiary amines of formula (II) include:

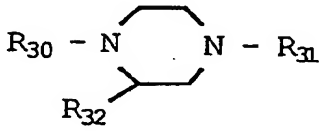








A third class of tertiary amines useful in compositions according to the invention comprises compounds having the formula (III):

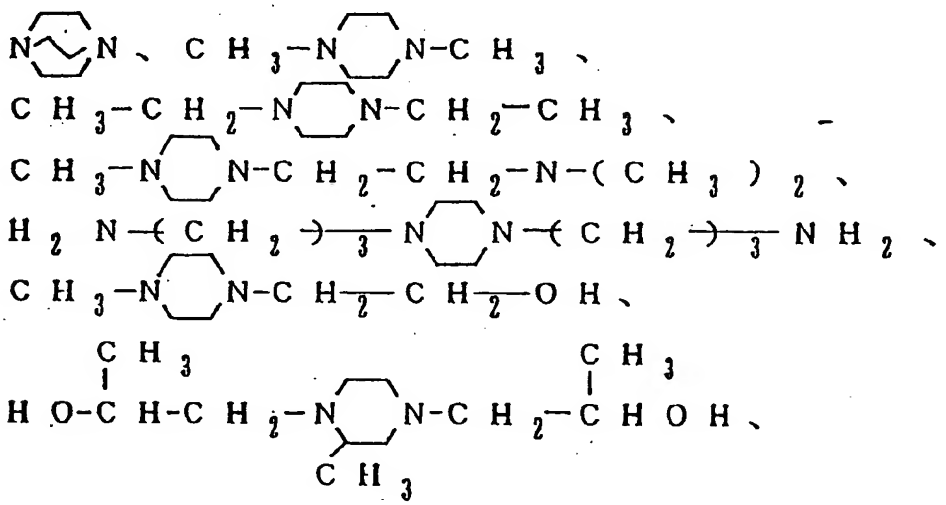


(III)

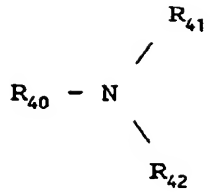
wherein each of R_{30} and R_{31}, which may be the same or different, represents an alkyl group containing up to 4 carbon atoms and optionally substituted by at least one N-, S- or O-containing substituent, or R_{30} and R_{31} together form an alkylene group, and R_{32} represents a hydrogen atom or a methyl group.

Examples of groups which may be present as R_{30} or R_{31} include methyl, ethyl, propyl, diethylaminoethyl and hydroxyethyl groups. Where R_{30} and R_{31} together form an alkylene chain this may, for example, be an ethylene chain.

Examples of specific tertiary amines of formula (III) include:-



A fourth class of tertiary amines useful in compositions according to the invention comprises compounds having the formula (IV):



(IV)

wherein each of R_{40} and R_{41}, which may be the same or different, represents an alkyl group containing up to 20 carbon atoms and optionally substituted by at least one N-, S- or O-containing substituent, or an optionally substituted cycloalkyl, aryl (e.g. phenyl) or N-, S-, O- or P-containing heterocyclic group bonded to the tertiary nitrogen atom either directly or by way of an alkylene group, and R_{42} represents an alkyl group containing up to 4 carbon atoms and optionally substituted by at least one N-, S- or O-containing substituent.

Examples of groups which may be present at R_{40} or R_{41} in formula (IV) include octyl, 2-hydroxyethyl, cyclohexyl, phenyl, benzyl and pyridyl groups. Groups such as phenyl and benzyl may be substituted by, for example, one or more alkyl groups (e.g. methyl or ethyl), alkoxy groups (e.g. methoxy or ethoxy) or halogen atoms (e.g. Cl or Br). Examples of R_{42} include methyl, ethyl, propyl, butyl and 2-hydroxyethyl groups.

Examples of specific tertiary amines of formula (IV) include

N, N-dimethylaniline
N, N-dimethylbenzylamine
N, N-dimethyldodecylamine
N, N-dicyclohexylmethylamine
triethylamine
triethanolamine
dibutylaminopropylamine

In formulae (I)-(IV) any N-containing substituents present may, for example, include primary amino groups, secondary amino groups such as lower (e.g. C_{1-6}) alkylamino, and tertiary amino groups such as di(lower alkyl)amino. O-containing substituents include hydroxy, epoxy, oxo and etherifying groups such as lower alkoxy; S-containing substituents include thio analogues of these groups.

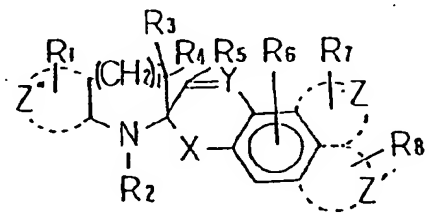
Alkylene groups present in any of formulae (I)-(IV) may, for example, contain up to 10, e.g. 1-6, carbon atoms, and may be straight or branched.

Cycloalkyl and cycloalkylene groups present in any of formulae (I), (II) and (IV) may, for example, contain up to 12, e.g. 5-7, carbon atoms.

Aryl groups present in any of formulae (I), (II) and (IV) may, for example, be mono- or bi-cyclic and contain up to 20, e.g. 6-12, carbon atoms.

Heterocyclic groups present in any of formulae (I), (II) and (IV) may, for example, contain one or more 5- or 6-membered rings, at least one of which will contain one or more heteroatoms, and may, for example, contain up to 20, e.g. 4-10, carbon atoms.

Organic photochromic compounds useful in compositions according to the invention include spiro compounds having the formula (V):



(V)

In the formula (V), i is an integer of 0 or 1; X is -O- or -S-; Y is one element selected from =CH-, $=CR_9$ and =N-; and each of Z, Z′ and Z″ may be present or may not be present, and if present, each of them is a saturated ring or an unsaturated ring which may contain a hetero atom. Examples of the above-mentioned saturated rings include a cyclohexyl ring and a cyclopentyl ring. Examples of the above-mentioned unsaturated rings include a benzene ring and a heterocyclic ring containing N, S or O.

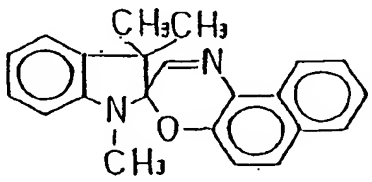
R_1, R_6, R_7 and R_8 in the formula (V) may be the same or different, and each of them is one element selected from a hydrogen atom, a halogen atom, a nitro group, an unsubstituted or substituted amino group, a hydroxyl group, an oxycarbonyl group, a carboxyl group, a sulfonic acid group, a carbamoyl group, a carboxyamide group, a sulfamoyl group, a sulfonamide group, a sulfanyl group, a sulfonyl group, a cyano group, an unsubstituted or substituted alkyl group, an unsubstituted or substituted aryl group, an alkoxy group, an aryloxy group, and an acyl group.

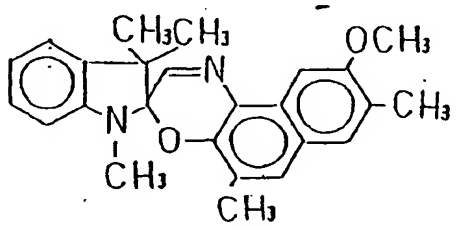
R_2 to R_5 and R_9 in the formula (V) may be the same or different, and each of them is a hydrogen atom, an unsubstituted or substituted alkyl group having 1 - 18 carbon atoms, an aralkyl group having 7 - 18 carbon atoms, or a cycloalkyl group having 4 - 10 carbon atoms.

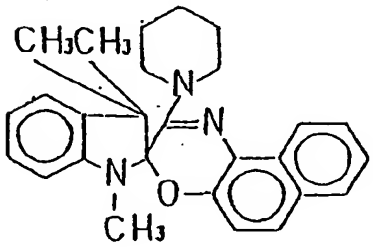
Examples of the substituting groups in each of R_1 to R_9 of the formula (V) include a halogen atom, an alkoxy group having 1 - 20 carbon atoms, an amino group, a nitro group, a monoalkylamino or dialkylamino group having 1 - 36 carbon atoms, a hydroxyl group, a carboxyl group, an oxycarboxyl group having 20 or less carbon atoms, an acyl group having 20 or less carbon atoms, an oxycarbonyl group having 20 or less carbon atoms, a carbamoyl group having 20 or less carbon atoms, and a sulfamoyl group having 20 or less carbon atoms.

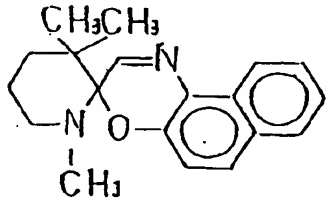
As examples of the spiro compounds, there can be mentioned the following spiroxazine compounds, spiropyran compounds and thiopyran compound:-

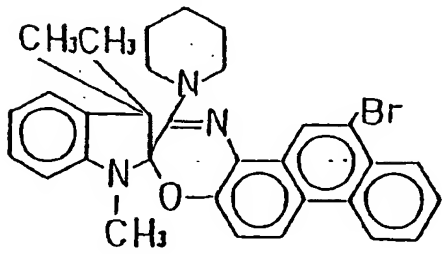
[Spiroxazine compound]



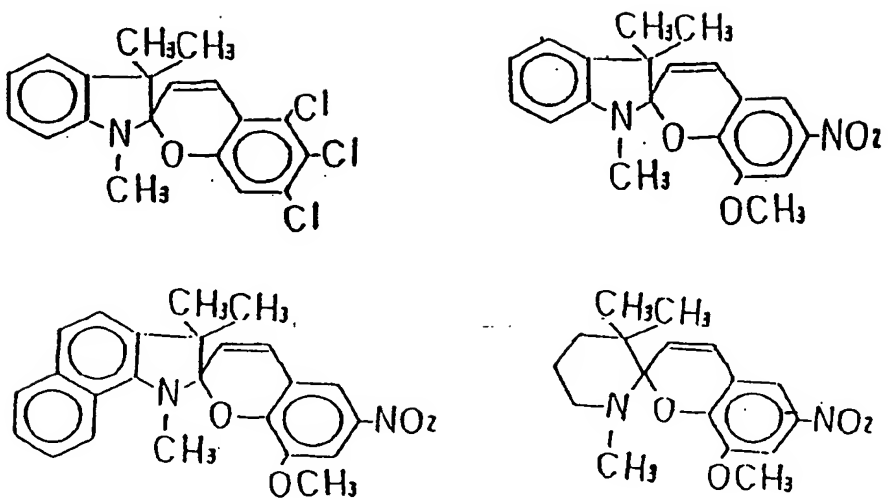




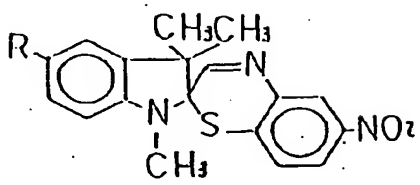




[Spiropyran compound]



[Thiopyran compound]



In the above formula, specific examples of R include $-OCH_3$, $-CH_3$, -H, -Cl and $-NO_2$.

The organic high molecular weight compound used as binder in compositions of the invention preferably has a good affinity for both the organic photochromic compound and the tertiary amine and preferably is optically transparent. Examples of such high molecular weight compounds include polymethylmethacrylate, polyvinyl acetate, polyvinyl butyral and polyvinyl alcohol.

In the photochromic compositions of the invention, the organic photochromic compound may, for example, be used in an amount of 0.01 to 25 parts by weight, e.g. 0.5 to 2 parts by weight, per 100 parts by weight of the organic high molecular weight compound. The tertiary amine compound may, for example, be used in an amount of 0.001 to 100 parts by weight, e.g. 3 to 30 parts by weight, per 100 parts by weight of the organic high molecular weight compound.

The photochromic compositions of the invention may incorporate a crosslinking agent such as an isocyanate compound, an epoxy compound, an amine compound, an ethyleneimine compound or a metal chelate compound in an appropriate amount, depending on the nature of the organic high molecular weight compound.

Furthermore, a plasticizer can be also added in an appropriate amount to the photochromic compositions of the invention, depending on the nature of the organic high molecular weight compound. Examples of plasticizers employable in the invention include phosphate derivatives such as trioctyl phosphate and triphenyl phosphate, adipate derivatives such as didecyl adipate and dibutyl adipate, sebacate derivatives such as dibutyl sebacate and dioctyl sebacate, azelate derivatives such as dioctyl azelate and dihexyl azelate, citrate ester derivatives such as triethyl citrate and tributyl citrate, glycol ester derivatives such as methyl phthalyl ethyl glycolate and butyl phthalyl butyl glycolate, trimellitate derivatives such as trioctyl trimellitate, phthalate derivatives such as dioctyl phthalate, ricinoleate derivatives such as methyl acetyl ricinoleate and butyl acetyl ricinoleate, polyester derivatives such as polypropylene adipate and polypropylene sebacate, epoxy derivatives such as epoxy butyl stearate and epoxy octyl stearate, and glycol derivatives such as polyethylene glycol and polypropylene glycol.

According to a further aspect of the invention, the novel photochromic compositions as hereinbefore defined may be prepared by a process which comprises adding an organic photochromic compound and a tertiary amine to a solution of an organic high molecular weight binder and thereafter recovering a photochromic composition from the resulting product mixture. If necessary or desired, a crosslinking agent and/or a plasticizer, e.g. as hereinbefore described, may also be added prior to recovery of the photochromic composition.

Examples of solvents which may be employed in this process include water; alcohols such as methanol or ethanol; ketones such as acetone, methyl ethyl ketone or methyl butyl ketone; aromatic solvents such as benzene, toluene or xylene; ethers such as diethyl ether or tetrahydrofuran; esters such as methyl acetate or ethyl acetate; and mixtures of two or more of these solvents.

Recovery of the photochromic composition from the product mixture may be effected by, for example, techniques such as solvent evaporation (e.g. by applying the mixture to a surface of a substrate by a coating method such as cast coating or roll coating, and drying the layer thus obtained to yield a material in the form of a laminate in which a photochromic layer is laminated onto a surface of the substrate), spray drying or similar methods (e.g. to form a particulate or powdered photochromic composition) or solvent precipitation (e.g. by adding the mixture, with stirring, to a solvent which has little or no solubility for the high molecular weight compound, and separating and drying the resulting precipitate to yield a granular photochromic composition).

Photochromic compositions obtained by such procedures may be further treated, e.g. by thermoforming techniques, to yield particular desired products. Thus, for example, a photochromic composition according to the invention may be melted and kneaded and thereafter subjected to injection molding or extrusion molding to yield a photochromic material, e.g. in the form of a film.

The invention also embraces the use of the novel photochromic compositions hereinbefore defined in the manufacture of photochromic materials such as films and laminates, e.g. using the above-described molding and coating techniques, and films and laminates so produced.

The following non-limitative Examples serve to illustrate the invention.

Example 1

In 23.3 g of a mixture solvent of toluene and 2-propanol (toluene : 2-propanol = 1 : 1) was dissolved 0.1 g of spiroindolinophenanthrooxazine having a peak absorption at 366 nm, and in the resulting solution was further dissolved 9.8 g of polyvinyl butyral (trade name: Denka Butyral #2000-L, available from Denki Kagaku Kogyo K.K.). Then, to the resulting solution was added 0.1 g of N,N,N′,N′-tetramethyl-1,6-diaminohexane (tertiary amine compound) and the mixture was stirred, to prepare 33.4 g of a solution.

The solution was applied on a polyethylene terephthalate base film having a thickness of 38 μm using a doctor blade, and the layer thus formed was dried at 80 °C for 3 minutes to form a photochromic layer having a thickness of 25 μm on the base film. Thus, a photochromic laminate was obtained.

The photochromic laminate thus obtained was colorless and transparent in the normal state, but developed a uniform color of blue violet when irradiating ultraviolet rays. Thus colored photochromic laminate returned to the initial colorless and transparent state by irradiation with infrared or visible rays or by heating.

The above-mentioned spiroindolinophenanthrooxazine is ring-opened under irradiation with ultraviolet rays to form a merocyanine structure, so as to develop a color. In this stage, if the compound deteriorates too much, the compound cannot return to the initial spiroindolinophenanthrooxazine structure even when the irradiation with the ultraviolet rays is terminated.

Therefore, the obtained photochromic laminate was evaluated on the light-resistance in the following manner

The colorless and transparent photochromic laminate in the initial state was measured on the absorbance A_0 at 366 nm (maximum absorption wavelength of spiroindolinophenanthrooxazine) by the use of a ultraviolet rays-infrared or visible rays automatic spectrophotometer (MPS-2000, produced by Shimazu Seisakusho Co.).

The photochromic laminate was then continuously irradiated with ultraviolet rays for the period of 50 hours and 100 hours using a carbon arc lamp equipped in a fade meter (CF-20S, produced by the same company). Thereafter, the photochromic laminate was heated to 80 °C to make the laminate completely colorless and transparent. This colorless and transparent photochromic laminate was measured on the absorbance A_t at 366 nm in the same manner as described above.

The values A_0 and A_t obtained as above were introduced into the following equation, to evaluate the light-resistance of the photochromic laminate.

Light-resistance (%) = $\{A_t / A_0\} \times 100$

In the evaluation on the light-resistance, the larger the value obtained by the above equation becomes, the higher the light-resistance of the laminate becomes.

The results are set forth in Table 1

Example 2

The procedures of Example 1 were repeated except for using N,N,N',N'-tetramethyl-p-phenylenediamine as the tertiary amine compound, to produce a photochromic laminate. The obtained photochromic laminate was evaluated on the light-resistance in the same manner as described in Example 1.

The results are set forth in Table 1.

Example 3

The procedures of Example 1 were repeated except for using N,N,N',N",N"-pentamethyl-diethylenetriamine as the tertiary amine compound, to produce a photochromic laminate. The obtained photochromic laminate was evaluated on the light-resistance in the same manner as described in Example 1.

The results are set forth in Table 1.

Example 4

The procedures of Example 1 were repeated except for using 1,3,5-tris(3-dimethylaminopropyl)hexahydro-s-triazine as the tertiary amine compound, to produce a photochromic laminate. The obtained photochromic laminate was evaluated on the light-resistance in the same manner as described in Example 1.

The results are set forth in Table 1.

Example 5

The procedures of Example 1 were repeated except for using 1,4-diazabicyclo[2,2,2]octane as the tertiary amine compound, to produce a photochromic laminate. The obtained photochromic laminate was evaluated on the light-resistance in the same manner as described in Example 1.

The results are set forth in Table 1.

Example 6

The procedures of Example 1 were repeated except for using N,N'-dimethylpiperazine as the tertiary amine compound, to produce a photochromic laminate. The obtained photochromic laminate was evaluated on the light-resistance in the same manner as described in Example 1.

The results are set forth in Table 1.

Example 7

The procedures of Example 1 were repeated except for using N,N-dimethylaniline as the tertiary amine compound, to produce a photochromic laminate. The obtained photochromic laminate was evaluated on the light-resistance in the same manner as described in Example 1.

The results are set forth in Table 1.

Example 8

The procedures of Example 1 were repeated except for using N,N-dimethylbenzylamine as the tertiary amine compound, to produce a photochromic laminate. The obtained photochromic laminate was evaluated on the light-resistance in the same manner as described in Example 1.

The results are set forth in Table 1.

Comparative Example 1

The procedures of Example 1 were repeated except for not using any tertiary amine compound, to produce a photochromic laminate. The obtained photochromic laminate was evaluated on the light-resistance in the same manner as described in Example 1.

The results are set forth in Table 1.

Comparative Examples 2 - 6

The procedures of Example 1 were repeated except for using a hindered phenol type antioxidant (trade name: Irganox 1010, available from Ciba-Geigy), a phosphite type antioxidant (trade name: Mark 135A, available from Adeca Argus Chemical Co. Ltd.), a thioether type antioxidant (trade name: AO-503A, available from Adeca Argus Chemical Co. Ltd.), a nickel metal complex type light stabilizer (trade name: Cyasorb UV1084, available from American Cyanamid Co.), and a hindered amine type light stabilizer (trade name: Sanol LS-770, available from Sankyo Co., Ltd.), respectively, as the tertiary amine compound, to produce photochromic laminates of Comparison Examples 2 to 6.

Subsequently, each of the photochromic laminates of Comparison Examples 2 to 6 was measured on the absorbance A_t in the same manner as described in Example 1, and they were evaluated on the light-resistance in the same manner as described in Example 1.

The results are set forth in Table 1.

Table 1

	Additives	Light-resistance	
		50 hours	100 hours
Example 1	N,N,N',N'-tetramethyl-1,6-diaminohexane	90	82
Example 2	N,N,N',N'-tetramethyl-p-phenylenediamine	90	80
Example 3	N,N,N',N",N"-pentamethyl-diethylenetriamine	91	84
Example 4	1,3,5-tris(3-dimethylaminopropyl)hexahydro-s-triazine	87	82
Example 5	1,4-diazabicyclo[2,2,2]octane	87	75
Example 6	N.N'-dimethylpiperazine	87	75
Example 7	N,N-dimethylaniline	85	69
Example 8	N,N-dimethylbenzylamine	86	70
Comp. Ex. 1	none	57	24
Comp. Ex. 2	hindered phenol (Irganox 1010)	64	38
Comp. Ex. 3	phosphite (Mark 135A)	41	21
Comp. Ex. 4	thioether (Mark AO-503A)	54	29
Comp. Ex. 5*	Ni complex (Cyasorb UV1084)	80	65
Comp. Ex. 6	hindered amine (Sanol LS-770)	73	45

The laminate indicated by the mark "*" was green owing to the nickel complex even before the laminate was irradiated with ultraviolet rays.

EP 0 467 552 A1

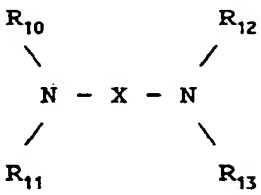
As is evident from the results set forth in Table 1, all of the photochromic laminates obtained in Comparison Examples 1 to 6 are lower than the photochromic laminates obtained in Examples 1 to 8 in both the light sensitivity for coloration and the light-resistance.

Further, it has been confirmed that the photochromic compositions of the present invention are more excellent in both the light sensitivity for coloration and the light-resistance as compared with the conventional photochromic compositions improved in the light-resistance, because the photochromic laminates obtained in Examples 1 to 8 and Comparison Examples 1 to 6 have the same structure except for their photochromic compositions.

Claims

1. A photochromic composition comprising an organic photochromic compound dissolved or dispersed in an organic high molecular weight binder, characterised in that a tertiary amine is also dissolved or dispersed in the said binder.

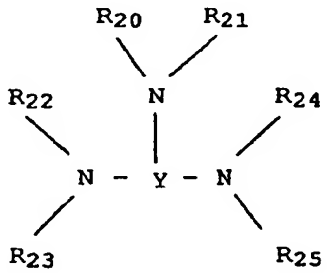
2. A photochromic composition as claimed in claim 1 in which said tertiary amine is a compound of formula (I)



(I)

wherein each of R_{10} to R_{13}, which may be the same or different, represents an alkyl or epoxyalkyl group containing up to 4 carbon atoms and optionally substituted by at least one N-, S- or O-containing substituent, and X is an alkylene group optionally including in the carbon chain thereof at least one of N, S or O and/or optionally carrying at least one N-, S- or O-containing substituent, or is an optionally substituted cycloalkylene, arylene or N-, S-, O- or P-containing heterocyclic ring or a plurality of such rings optionally interlinked by one or more alkylene groups.

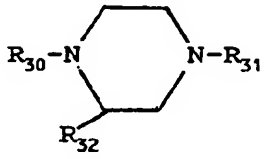
3. A photochromic composition as claimed in claim 1 in which said tertiary amine is a compound of formula (II)



(II)

wherein each of R_{20} to R_{25}, which may be the same or different, represents an alkyl group containing up to 4 carbon atoms and optionally substituted by at least one N-, S- or O-containing substituent, and Y is an optionally substituted cycloalkane or N-, S-, O- or P-containing heterocyclic ring, said cycloalkane or heterocyclic ring being bonded to each tertiary nitrogen atom either directly or by way of an alkylene group optionally containing at least one of N, O or

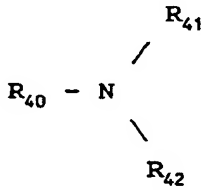
4. A photochromic composition as claimed in claim 1 in which said tertiary amine is a compound of formula (III)



(III)

wherein each of R_{30} and R_{31}, which may be the same or different, represents an alkyl group containing up to 4 carbon atoms and optionally substituted by at least one N-, S- or O-containing substituent, or R_{30} and R_{31} together form an alkylene group, and R_{32} represents a hydrogen atom or a methyl group.

5. A photochromic composition as claimed in claim 1 in which said tertiary amine is a compound of formula (IV)



(IV)

wherein each of R_{40} and R_{41}, which may be the same or different, represents an alkyl group containing up to 20 carbon atoms and optionally substituted by at least one N-, S- or O-containing substituent, or an optionally substituted cycloalkyl, aryl or N-, S-, O- or P- containing heterocyclic group bonded to the tertiary nitrogen atom either directly or by way of an alkylene group, and R_{42} represents an alkyl group containing up to 4 carbon atoms and optionally substituted by at least one N-, S- or O-containing substituent.

6. A process for the preparation of a photochromic composition as defined in any of claims 1 to 5 which comprises adding an organic photochromic compound and a tertiary amine, optionally together with a crosslinking agent and/or a plasticiser, to a solution of an organic high molecular weight binder and thereafter recovering a photochromic composition from the resulting product mixture.

7. A process as claimed in claim 6 wherein the photochromic composition is recovered from the product mixture by solvent evaporation, spray drying or solvent precipitation.

8. A process as claimed in claim 6 or claim 7 wherein the photochromic composition is subsequently thermoformed to yield a desired product.

9. A photochromic film comprising a photochromic material as defined in any of claims 1 to 5.

10. A photochromic laminate comprising a layer of a photochromic material as defined in any of claims 1 to 5 on a surface of a substrate.

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 30 6004

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-0 350 009 (KUREHA KAGAKU KOGYO K.K.) * page 5, lines 22-27; page 13, lines 18-25 *	1,4	C 09 K 9/02 G 03 C 1/685
A	* page 9, lines 1-8 *	6	
X	US-A-3 322 542 (E. ULLMANN et al.) * whole document, in particular column 7 *	1-10	
Y		1-10	
Y	PATENT ABSTRACTS OF JAPAN vol. 13, no. 302 (C-616)(3650), 12 July 1989; & JP - A - 190285 (TOKUYAMA SODA CO.) 06.04.1989	1-10	
X	PATENT ABSTRACTS OF JAPAN vol. 14, no. 189 (P-1037)(4132), 17 April 1990; & JP - A - 235442 (NISSAN MOTOR CO.) 06.02.1990	1,4	
A	EP-A-0 195 898 (AMERICAN OPTICAL CORP.) * claims 1,2,8 *	1-10	TECHNICAL FIELDS SEARCHED (Int. Cl.5) C 09 K 9/00 G 03 C 1/00
A	PATENT ABSTRACTS OF JAPAN vol. 12, no. 5 (C-467)(2852), 8 January 1988; & JP - A - 62164685 (TORAY IND.)	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
BERLIN	14-10-1991	STOCK H

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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